CLAIMS

[1] An infant movement analysis system comprising:

an imaging device that photographs an infant to output a motion picture of the infant as digital data; and

an analyzing device that determines movements of four limbs of the infant from the motion picture of the infant who is photographed by said imaging device and identifies a disease and/or a symptom of the infant from correlativity of movements of a plurality of arms and/or legs out of the four limbs.

[2] The infant movement analysis system according to claim 1, wherein said analyzing device includes: a feature image extracting means for extracting, from the image of the infant, marker images of markers attached to the four limbs of the infant or feature images of the four limbs of the infant once every one frame or plural frames; a limb movement determining means for determining the movement of each of the limbs based on positions of the plural marker images or the plural feature images which are extracted in time series by said feature image extracting means; a movement analyzing means for extracting right-left synchronism of the arms or the legs, right-left symmetry of the arms or the legs, and/or coordination among the plural limbs, in the movements of the four limbs determined by said limb movement determining means; and a judging means for judging existence/nonexistence or a value of possibility of a disease and/or a symptom of the infant based on degree of the right-left synchronism, the right-left symmetry, and/or the coordination which are extracted by said movement analyzing means.

[3] The infant movement analysis system according to claim 2,

wherein said feature image extracting means extracts a marker image of a reference point marker attached to at least one of head, breast, abdomen, and lumbar region other than the four limbs of the infant, and

wherein said limb movement determining means determines the movement of each of the limbs based on an absolute position of the marker image of each of the limbs in the image and/or a relative position of the marker image of each of the limbs to a position of the marker image of the reference point marker in the image.

[4] The infant movement analysis system according to claim 2,

wherein said movement analyzing means determines existence/nonexistence or the degree of the right-left synchronism, and/or the right-left symmetry of the arms or the legs, using as index at least one of:

positions where the markers stop for a predetermined period or longer at a predetermined frequency or lower or at a predetermined frequency or higher;

positions through which the markers pass at a predetermined frequency or lower or at a predetermined frequency or higher;

movement ranges of the markers;

space volumes by movements of the markers;

kinetic momentums of the limbs determined based on the movements of the markers; and

positions of the markers when the markers are at a specific speed, acceleration, and/or deceleration.

[5] The infant movement analysis system according to claim 2,

wherein said movement analyzing means determines existence/nonexistence or the degree of the coordination among the plural

limbs, using as index one factor or a plurality of factors selected from:

a movement start order and movement start accelerations of the markers when the markers start moving from a stop state;

a movement stop order and movement stop decelerations of the markers when the markers stop from the moving state;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to two right and left limbs out of the four limbs, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to left arm and right arm, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to left leg and right leg, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting the two markers attached to the left arm and the right leg, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting the two markers attached to the left leg and the right arm, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint; and

at least one of a trajectory of a gravity center of a plane or a solid including three or four markers attached to three limbs or four limbs out of the four limbs, speed of the gravity center, acceleration of the gravity center, and deceleration of the gravity center.

[6] The infant movement analysis system according to claim 1, wherein the

markers attached to the four limbs of the infant are coated with or contain a substance that emits light when receiving ultraviolet or a phosphor.

[7] An infant movement analysis system comprising:

a database that stores movement data indicating histories of movements of four limbs of an infant, the movements being determined from a motion picture of the infant photographed by an imaging device that photographs an infant to output a motion picture of the infant as digital data; and

an analyzing device that identifies a disease of the infant from correlativity of movements of a plurality of arms and/or legs out of the four limbs, based on the movement data stored in said database.

[8] The infant movement analysis system according to claim 7, wherein said analyzing device includes: a feature image extracting means for extracting, from the image of the infant, marker images of markers attached to the four limbs of the infant or feature images of the four limbs of the infant once every one frame or plural frames; a limb movement determining means for determining the movement of each of the limbs based on positions of the plural marker images or the plural feature images which are extracted in time series by said feature image extracting means; a movement analyzing means for extracting right-left synchronism of the arms or the legs, right-left symmetry of the arms or the legs, and/or coordination among the plural limbs, in the movements of the four limbs determined by said limb movement determining means; and a judging means for judging existence/nonexistence or a value of possibility of a disease and/or a symptom of the infant based on degree of the right-left synchronism, the right-left symmetry, and/or the coordination which are extracted by said movement analyzing means.

[9] The infant movement analysis system according to claim 8,

wherein said feature image extracting means extracts a marker image of a reference point marker attached to at least one of head, breast, abdomen, and lumbar region other than the four limbs of the infant, and

wherein said limb movement determining means determines the movement of each of the limbs based on an absolute position of the marker image of each of the limbs and/or a relative position of the marker image of each of the limbs to a position of the marker image of the reference point marker in the image.

[10] The infant movement analysis system according to claim 8,

wherein said movement analyzing means determines existence/nonexistence or the degree of the right-left synchronism and/or the right-left symmetry of the arms or the legs, using as an index at least one of:

positions where the markers stop for a predetermined period or longer at a predetermined frequency or lower or at a predetermined frequency or higher;

positions through which the markers pass at a predetermined frequency or lower or at a predetermined frequency or higher;

movement ranges of the markers;

space volumes by movements of the markers;

kinetic momentums of the limbs determined based on the movements of the markers; and

positions of the markers when the markers are at a specific speed, acceleration, and/or deceleration.

[11] The infant movement analysis system according to claim 8,

wherein said movement analyzing means determines existence/nonexistence or the degree of the coordination among the plural

limbs, using as index one factor or a plurality of factors selected from:

a movement start order and movement start accelerations of the markers when the markers start moving from a stop state;

a movement stop order and movement stop decelerations of the markers when the markers stop from the moving state;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to two right and left limbs out of the four limbs, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to left arm and right arm, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting two markers attached to left leg and right leg, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting the two markers attached to the left arm and the right leg, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint;

at least one of a trajectory of a midpoint of a straight line connecting the two markers attached to the left leg and the right arm, speed of the midpoint, acceleration of the midpoint, and deceleration of the midpoint; and

at least one of a trajectory of a gravity center of a plane or a solid including three or four markers attached to three limbs or four limbs out of the four limbs, speed of the gravity center, acceleration of the gravity center, and deceleration of the gravity center.

[12] An infant movement analysis system comprising:

a database that stores a plurality of movement data indicating histories of movements of four limbs of a plurality of infants, the movements being determined from motion pictures of the plural infants photographed by an imaging device that photographs an infant to output a motion picture of the infant as digital data; and

an analyzing device that judges whether or not an infant newly photographed has a disease or not, according to a judgment condition which is set based on distribution of movement data of infants judged as normal infants with respect to the disease and/or distribution of movement data of infants judged as having the disease, out of the plural movement data stored in said database.

[13] An infant movement analysis method comprising the steps of:

photographing an infant and converting a motion picture of the infant to digital data;

determining movements of four limbs of the infant from the motion picture of the photographed infant; and

identifying a disease and/or a symptom of the infant from correlativity of movements of a plurality of arms and/or legs out of the four limbs.

[14] An infant movement analysis method comprising the steps of:

by using a database that stores a plurality of movement data indicating histories of movements of four limbs of a plurality of infants, which are determined from motion pictures of the plural infants photographed by an imaging device that photographs an infant to output a motion picture of the infant as digital data, generating a judgment condition based on distribution of movement data of infants judged as normal with respect to a disease and/or distribution of movement data of infants judged as having the disease, out of

the plural movement data stored in the database; and

judging, according to the generated judgment condition, whether or not a newly photographed infant has the disease.

[15] An infant movement analysis system comprising:

an imaging device that photographs an infant to output a motion picture of the infant as digital data; and

an analyzing device that determines a movement of a marker attached to at least one limb out of four limbs of the infant, from the motion picture of the infant photographed by said imaging device and identifies a disease and/or a symptom of the infant from the determined movement of the marker.

[16] An infant movement analysis method comprising the steps of:

photographing an infant and converting a motion picture of the infant to digital data;

determining a movement of a marker attached to at least one of four limbs of the infant, from the motion picture of the photographed infant; and

identifying a disease and/or a symptom of the infant from the determined movement of the marker.